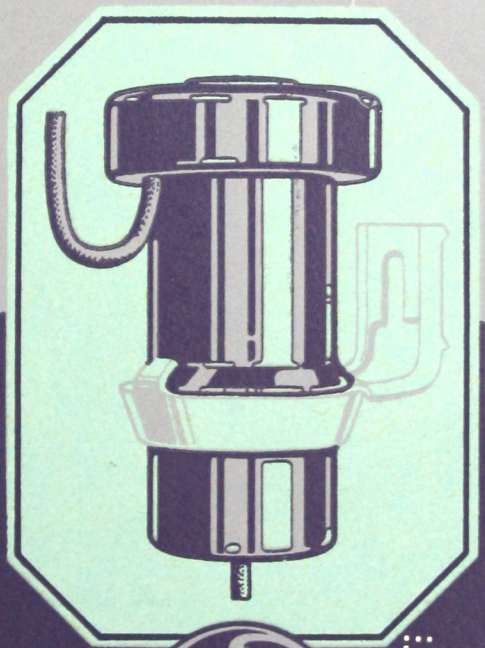
DISTRIBUTION LIGHTNING ARRESTERS FOR POLE MOUNTING



FRANKLIN INSTITUTE
PHILADELPHIA

791-7.

DISTRIBUTION LIGHTNING ARRESTERS

FOR POLE MOUNTING

PELLET TYPE

COMPRESSION-CHAMBER TYPE

GENERAL ELECTRIC COMPANY
SCHENECTADY, N. Y.

MAY, 1932

GEA-93H
Supersedes GEA-93G

The highly efficient performance of General Electric pellet lightning arresters has been established by most exacting tests, both in the laboratory and in the field. It has been further verified by the excellent operating record, over a period of nine years, of hundreds of thousands of pellet arresters in greatly diversified applications.

G-E pellet arresters permit distribution systems to be operated with virtual immunity from interruptions of service due to lightning.

Self-contained protection for G-E distribution transformers is provided by the new G-E Intershunt Thyrite arrester. This arrester is designed for internal mounting within standard transformers, 150 kv-a. and smaller, of the 2400- and 4800-volt classes, and for "interconnection", with the arrester directly shunting the insulation to be protected. The Intershunt arrester is the simplest and most economical means of obtaining the maximum advantages of "interconnection." See Publication GEA-1611.

Major Considerations in the Protection of Distribution Systems

THE application of lightning arresters to distribution systems is a warranted investment in that it minimizes lightning flashovers, failures of transformers, and blowing of primary fuses— thereby providing the utmost in continuity of power service. Present-day effort toward greatly increased efficiency and reliability of distribution systems should include a careful selection and installation of arresters to obtain the highest degree of protection.

The insulation strength of the ordinary distribution line is high as compared with the strength of the connected apparatus. Thus, the lightning voltages imposed on connected apparatus may be many times its insulation strength. Moreover, the close proximity of this equipment along the lines and the fact that over relatively short lines the lightning surges are attenuated but slightly, make all equipment vulnerable throughout the entire distribution system. Adequate protection of the system, therefore, essentially involves the apparatus rather than the line insulation. Economical practice includes no general effort to protect the lines, except insofar as they may benefit by those lightning arresters installed to protect the apparatus.

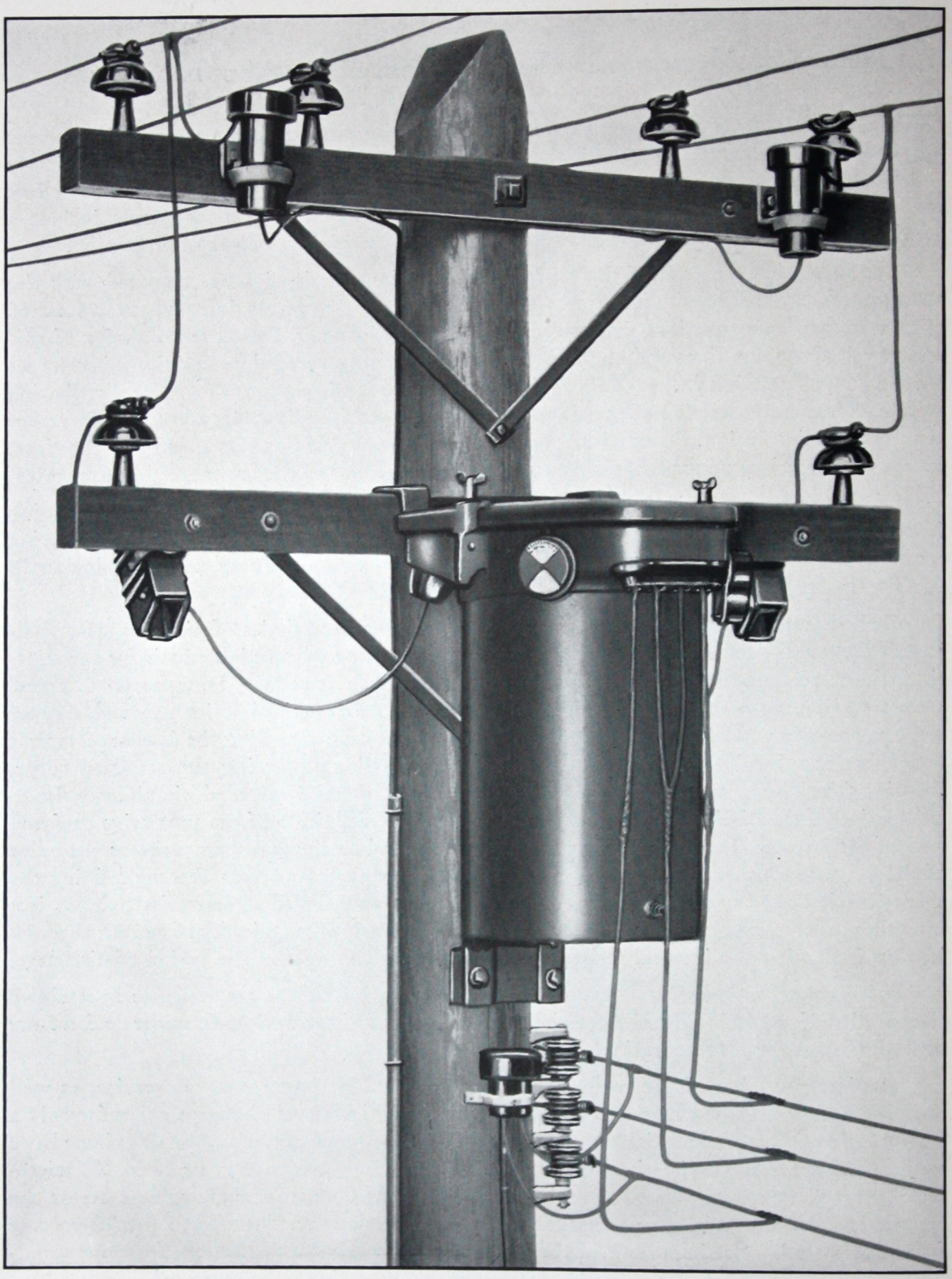
Of prime importance is the protection of station equipment by arresters on each outgoing feeder and of distribution transformers at their point of installation. In addition, metering equipment, sectionalizing switches or cutouts, and aërial or underground cable terminals will usually require protection.

Cathode-ray oscillograms, showing the protective characteristics of arresters when subjected to the proposed A.I.E.E. standard test surge, form the most reliable basis for the selection of arresters that will give maximum protection. Such tests must be made on complete arresters and should show the breakdown voltage of the combined series gap and arrester element preceding current flow, as well as the IR voltage drop attending the discharge current flow after gap breakdown. An actual volt-ampere oscillogram, using the standard surge, showing breakdown voltage followed by current and voltage recorded simultaneously to completion of the discharge, provides the most complete definition of the protective performance of the arrester. The breakdown voltage thus recorded on the oscillogram shows the value of the surge voltage required to start current flow through the arrester, thereby defining the speed (or time lag) to start discharge. The subsequent volt-ampere characteristic shows just how the surge voltage across the arrester is affected by various magnitudes of current through it, thus indicating the internal resistance of the arrester throughout the period of discharge.

Furthermore, such test data on arresters of representative ratings are desirable to establish the validity of predicting the characteristics of arresters of higher ratings from the performance of similar arresters of lower ratings.

The interpretation of test performance is of considerable importance. In service, as well as in laboratory tests, the arrester breakdown voltage which starts discharge exists for only a fraction of a microsecond and is not affected by the series ground resistance. The IR or impedance voltage exists for the entire time of discharge current flow—which may be 20 to 100 microseconds for the complete discharge. Also, during current flow, to the IR voltage across the arrester is added the IR voltage across the series ground resistance. Therefore, a low IR voltage for the arrester is most important in the attainment of maximum protection, from the standpoint of both duration and magnitude of stress on the insulation to be protected.

A low-resistance ground connection contributes materially to the protective efficiency of arrester installations. The most effective protection of distribution transformers can be gained by interconnection of the primary arrester between primary circuit and the neutral or other terminal of the secondary which is reliably grounded. Such interconnection eliminates the influence of ground resistance, placing the arrester directly in shunt with the insulation to be protected. Further information on this subject is contained in publication GEA-1572.



Typical single-phase installation on 2300-volt delta circuit—pellet arresters on primary circuit—double-pole compression-chamber arrester on secondary circuit

Pellet-type Arresters

The G-E pellet arrester gives distribution systems virtual immunity from lightning disturbances. It has established an excellent service operating record during the nine years of its widespread application. The electrical characteristics, physical design, and low cost of pellet arresters make them highly suitable for protection of distribution transformers, moderate-sized substations, cable terminals, a-c. series lighting equipment, and railway-signal primary circuits.

Fig. 1. Pellet arrester—1000 to 3000 volts

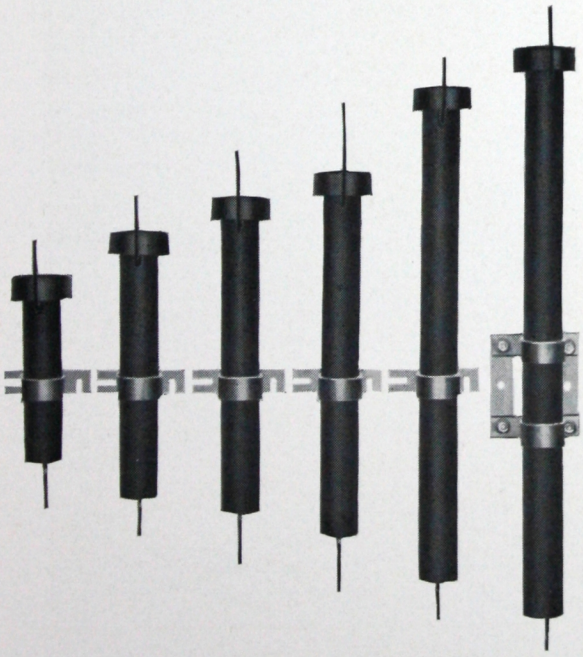


Fig. 2. Pellet arresters of various ratings from 3 kv. minimum to 20 kv. maximum

The pellet arrester is built in single-pole units for outdoor service on a-c. circuits from 1 to 73 kv. Each design has minimum and maximum voltage ratings suitably proportioned to standard system ratings. The maximum rating represents the maximum permissible system operating voltage (rms.) to be applied to the arrester.

The construction of the pellet-type arrester is illustrated by Fig. 1. The electric elements consist of a column of pellets and a series gap assembly. The pellet column forms the valve element pre-

Fig. 3. Suspension design of pellet arrester rated 12 to 15 kv.

venting the flow of system current following discharge, while the series gap isolates the valve element from the line until it is sparked over by a surge. The pellets, about $\frac{3}{16}$ inch in diameter, are made of lead peroxide with a thin porous coating of litharge, and are assembled in porcelain tube containers with metal electrodes in contact with each end of the pellet column. The column is 2 $\frac{1}{4}$ inches in diameter, and its length is approximately 2 inches per kv. of arrester rating.

In the pellet-arrester designs up to 20 kv. (see Fig. 2) the pellet column, series gap assembly, and a spring assembly for exerting a rigid contact pressure, are contained in a single porcelain tube with a porcelain cap secured by a weatherproof compound of high flow point. Flexible leads, securely soldered, provide for line and ground connections. A double-galvanized steel hanger provides for mounting.

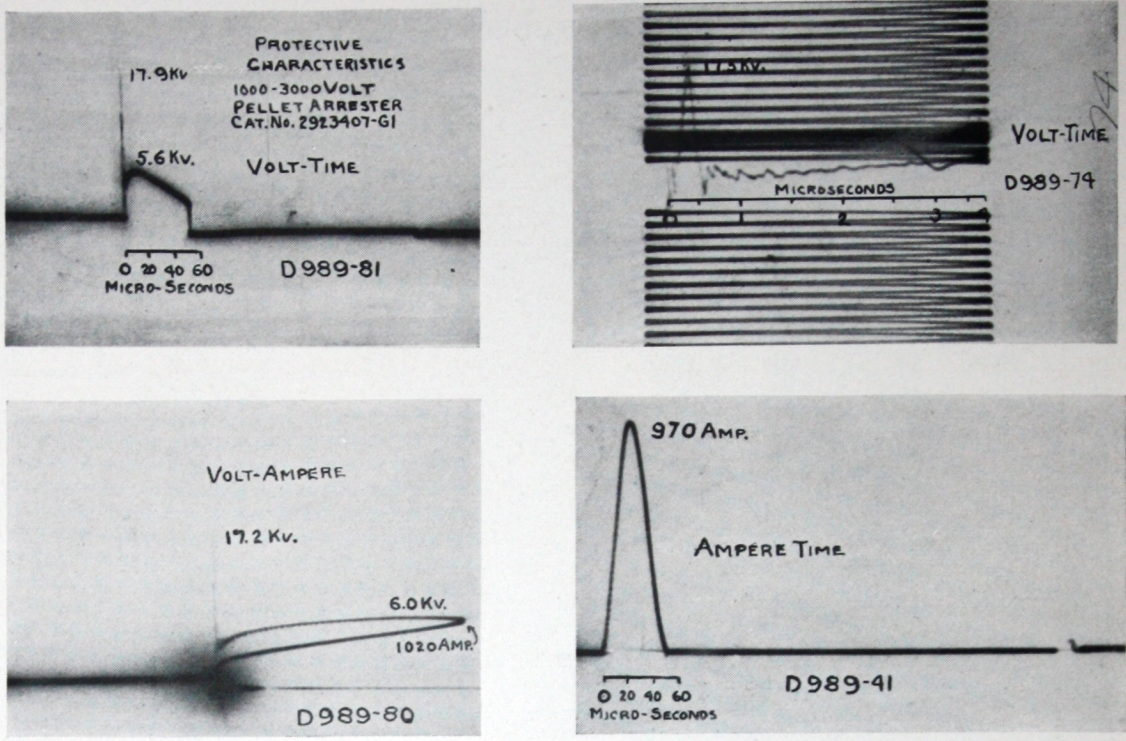


Fig. 4. Cathode-ray oscillograms showing impulse protective characteristics of pellet arresters rated 1 to 3 kv.

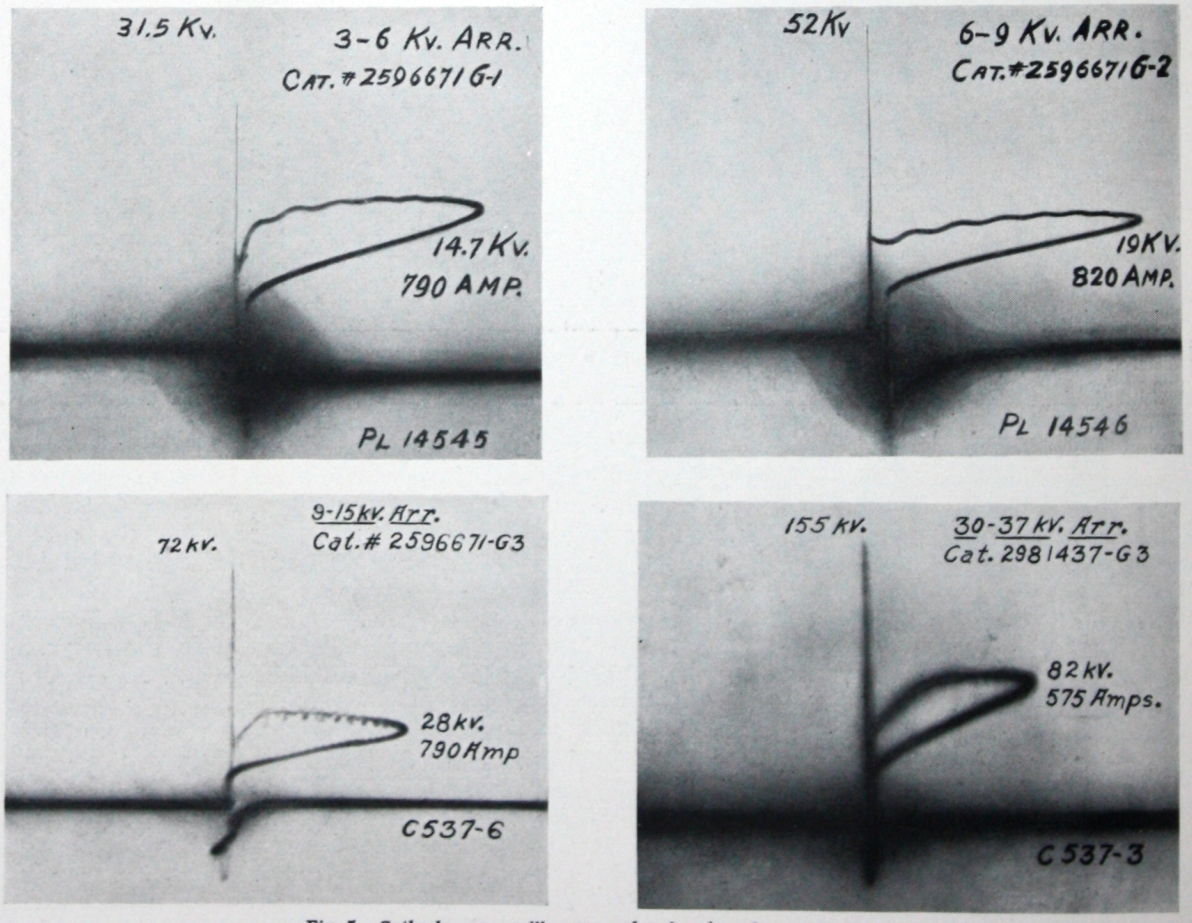


Fig. 5. Cathode-ray oscillograms showing impulse protective characteristics of pellet arresters above 3-kv. rating

The arresters maximum-rated 9 kv., 12 kv., 15 kv., 18 kv., and 20 kv. can be supplied for suspension mounting as shown in Fig. 3.

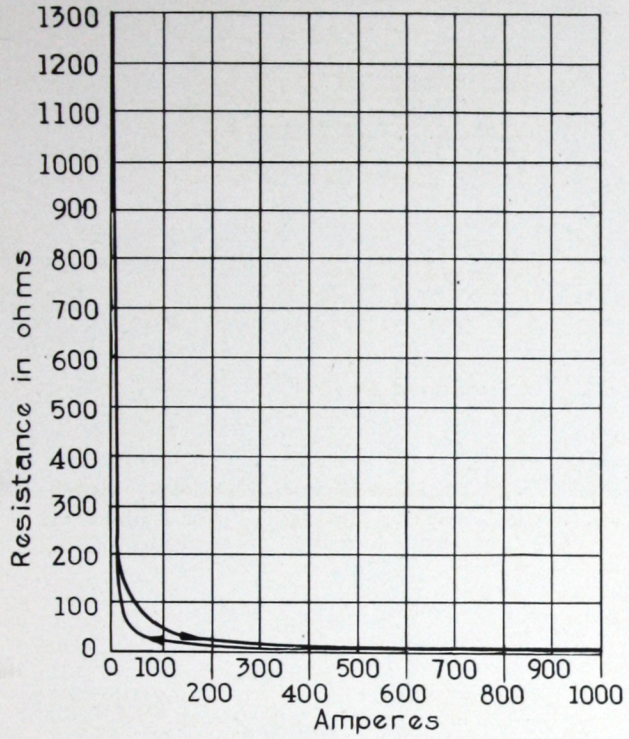


Fig. 6. Current-resistance relationship existing in 3-kv. pellet arrester

In the designs rated above 20 kv. (see Fig. 10), the pellet column assembly is divided into two or more units in series and supported on an insulator assembly with the enclosed series sphere gap at the top.

Well-glazed wet-process porcelains are used throughout pellet arresters of all ratings.

The valve performance of the pellet column is well illustrated by the oscillogram, Fig. 4, which shows the voltage and current relations existing in the pellet column of a 3-kv. arrester. After gap breakdown, current begins to flow, and the resistance of the pellet column decreases as long as the current increases; but when the current begins to decrease, the resistance increases. These relationships, shown in Fig. 6, are derived directly from the oscillogram, Fig. 4. Thus, at the end of a discharge the resistance of the pellet column has increased sufficiently so that normal system voltage is unable to maintain a current flow through the arrester.

This valve action is independent of any current-suppressing property of the series gap, and thus the arresters are not restricted to low-voltage ratings. Pellet arresters of 22-, 33-, 44-, and 66-kv. ratings simply employ a proportionately longer pellet column and a single series gap.

Protective Characteristics of Pellet Arresters

The cathode-ray oscillograms in Fig. 4 show the complete protective characteristics of the pellet arrester maximum-rated 3 kv. (rms.). All voltage and current figures represent crest instantaneous values. The rate of rise of the applied surge voltage and current conforms to the proposed A.I.E.E. standard surge wave, but the discharge current is appreciably more severe than the required 750 amperes specified by this standard. The arrester holds the surge voltage to 6-kv. crest during discharge, which value is only $1\frac{1}{2}$ times the 4.2-kv. crest rating of the arrester.

Fig. 5 shows the volt-ampere performance characteristics for pellet arresters maximum-rated 6 kv., 9 kv., 15 kv., and 37 kv. It is seen that the average surge voltage allowed by the arresters during discharge is closely proportionate to their ratings, and is always less than two times the crest voltage rating of the arresters.

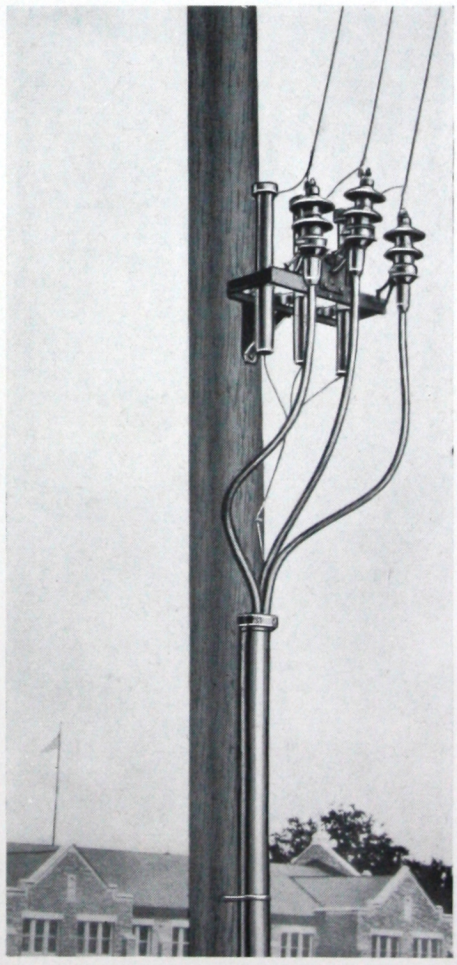


Fig. 7. 15-kv. pellet arresters protecting cable terminals

Installations of Pellet Arresters

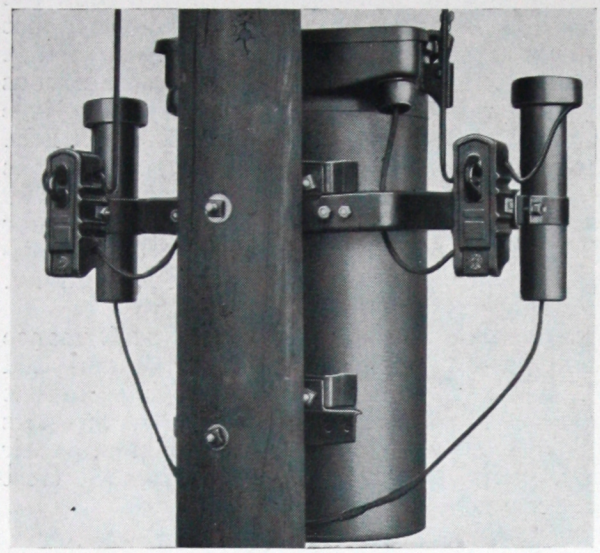


Fig. 8. 4600-volt installation of transformer, cutouts, and pellet arresters, using G-E unit-mounting equipment described in Bulletin GEA-1555

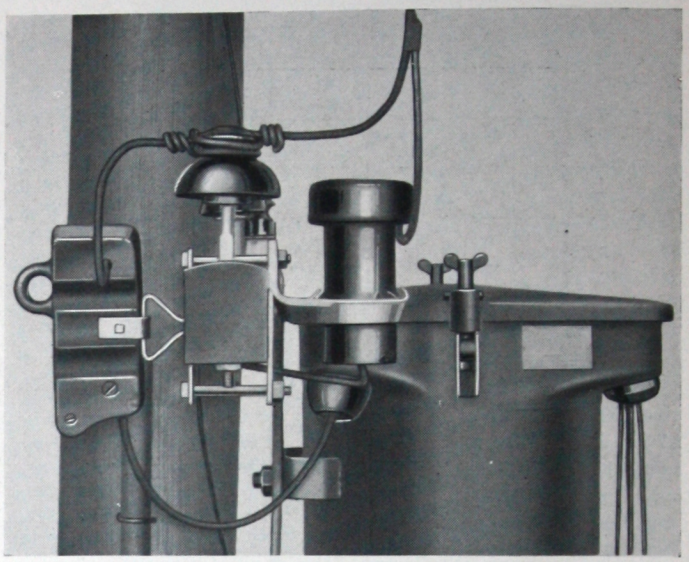


Fig. 9. Combination cross-arm mounting of pellet arrester and primary cutout for 2300-volt circuits

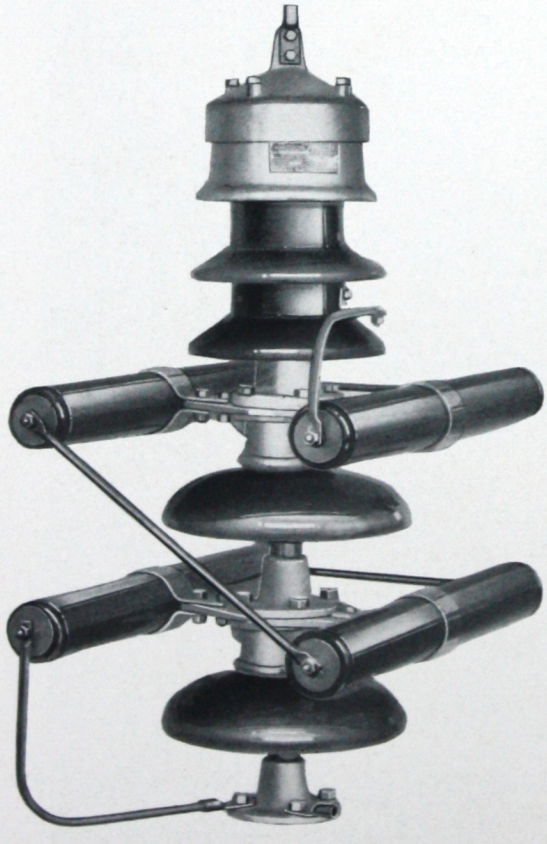


Fig. 10. Pellet arrester rated 30–37 kv.

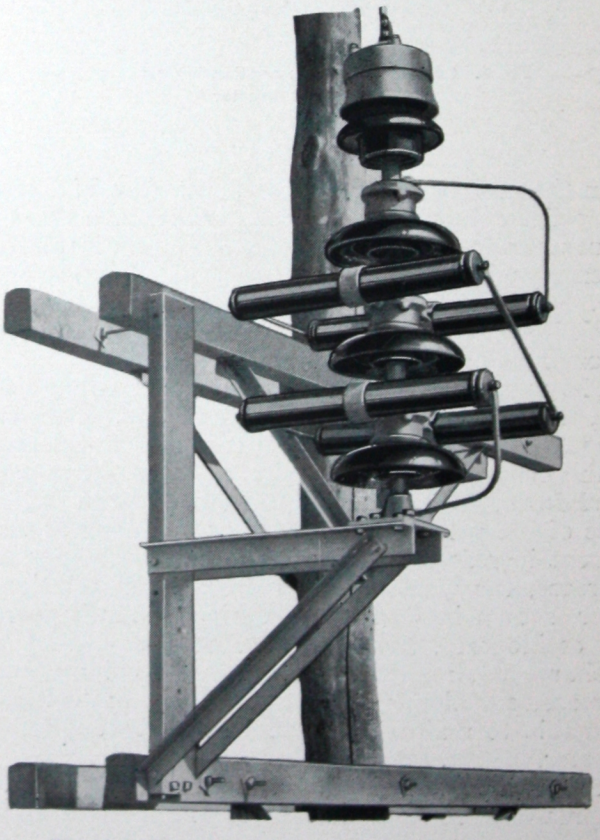


Fig. 11. 37-kv. pellet arrester with bracket mounting

Installations of Pellet Arresters

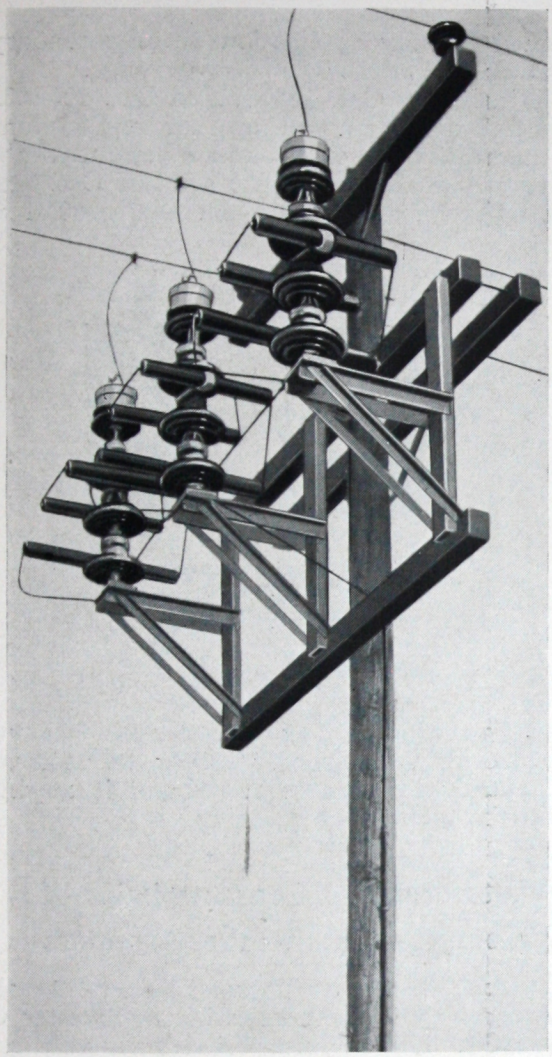


Fig. 12. 30-kv. pellet arresters, three-phase pole installation

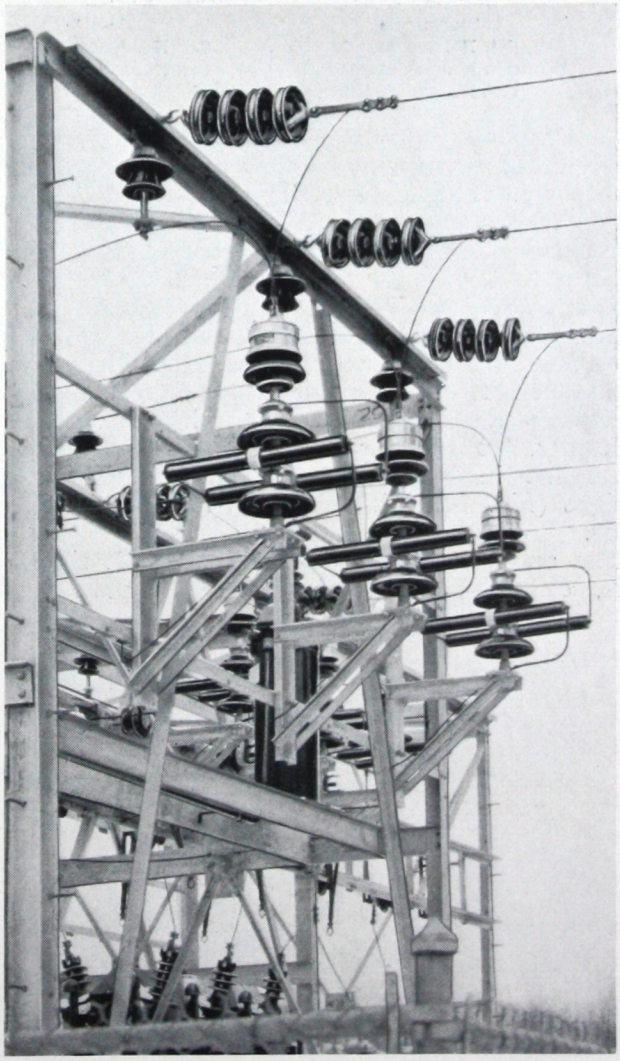


Fig. 13. 22-kv. pellet arresters protecting industrial substation

Compression-chamber Arrester

for low-voltage a-c. circuits

The compression-chamber arrester is recommended for low-voltage a-c. circuits up to 750 volts. This includes secondary lighting and power circuits, railway-signal circuits, and the neutrals of 3-phase, 4-wire distribution feeders.

This arrester consists essentially of an enclosed air gap using brass-alloy electrodes which give off arc vapors, causing a rectifying effect which extinguishes power current flow at the zero point of the a-c. voltage wave. This arc-extinguishing action of the gap is aided by a very low series resistance rod which enables the use of the single gap up to 750 volts rating. The gap unit and resistance rod are housed in a well-glazed porcelain container provided with line and ground leads and galvanized-steel hanger. High insulation resistance between lines and hanger is provided by the generous proportions of the glazed porcelain container. To simplify installation, the arresters are made in both single-pole and double-pole designs (Fig. 14), with either 18-in. or 36-in. line leads.

The arresters Cat. 2906822G1 and G2, single-pole, or 2906823G1 and G2, double-pole, are designed for any application on all secondary or signal circuits in the 0 to 750-volt range.

The arresters Cat. 146187 and Cat. 2906822G3 have a larger gap and are for application on the neutral wire of grounded-neutral 3-phase, 4-wire primary circuits. The arrester Cat. 146187 (Fig. 15) can be used when the neutral wire voltage to ground does not exceed 300 volts. The arrester Cat. 2906822G3 can be used when the neutral-wire voltage to ground is anywhere within the 0 to 750-volt rating.

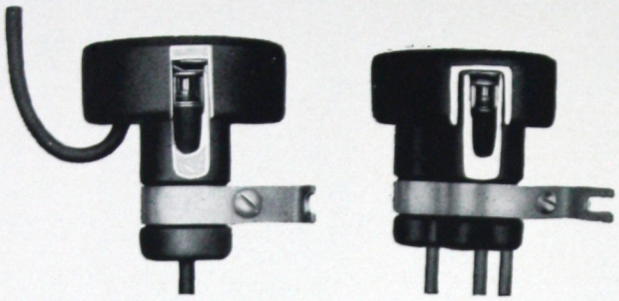


Fig. 14. Compression-chamber arresters with section of porcelain cut away to show gap and resistance rod

Single-pole	Double-pole
Cat. No. 2906822G1	Cat. No. 2906823G1
Cat. No. 2906822G2	Cat. No. 2906823G2
Cat. No. 2906822G3	

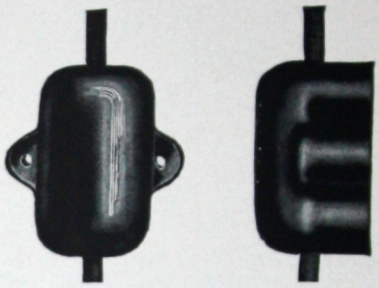


Fig. 15. Compression-chamber arrester Cat. No. 146187

Performance Characteristics of Compression-chamber Arresters

The cathode-ray oscillograms in Fig. 16 show the protective characteristics of the arrester Cat. 2906822G1. The impulse breakdown voltage of the arrester averages 3-kv. crest, and the IR voltage following breakdown is 1.5-kv. crest. This performance provides excellent protection to apparatus insulation involved with the 0 to 750-volt circuits.

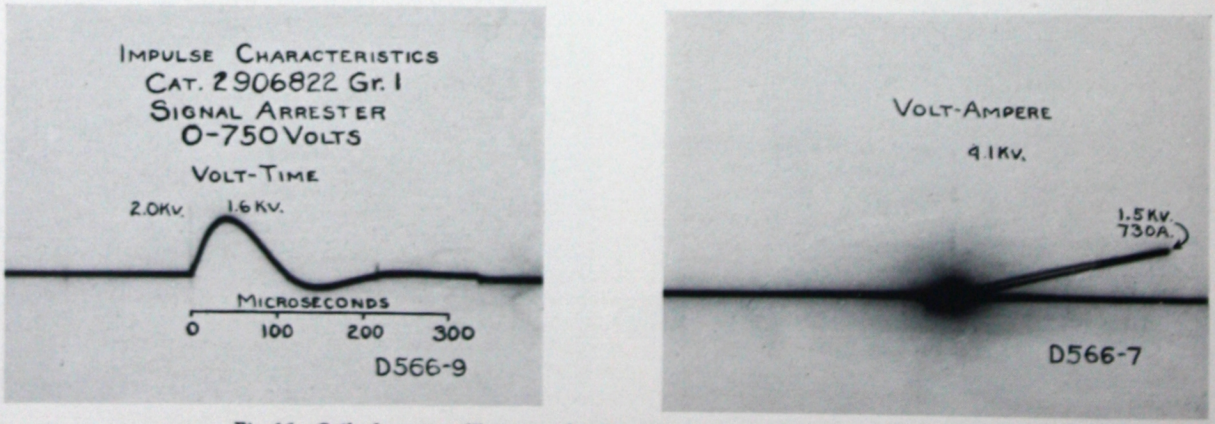


Fig. 16. Cathode-ray oscillograms showing impulse protective characteristics of Cat. 2906822G1 arrester rated 0 to 750 volts

Arrester Applications

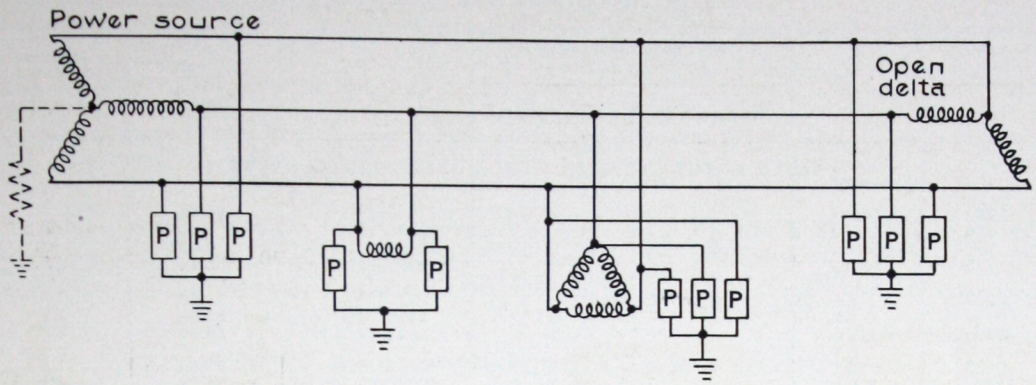


Fig. 17. Three-phase and single-phase applications to three-phase, ungrounded neutral systems, or systems with neutral grounded through resistance or reactance.

"P" represents pellet arresters—rating selected on basis of line-to-line voltage. See Table 1, next page.

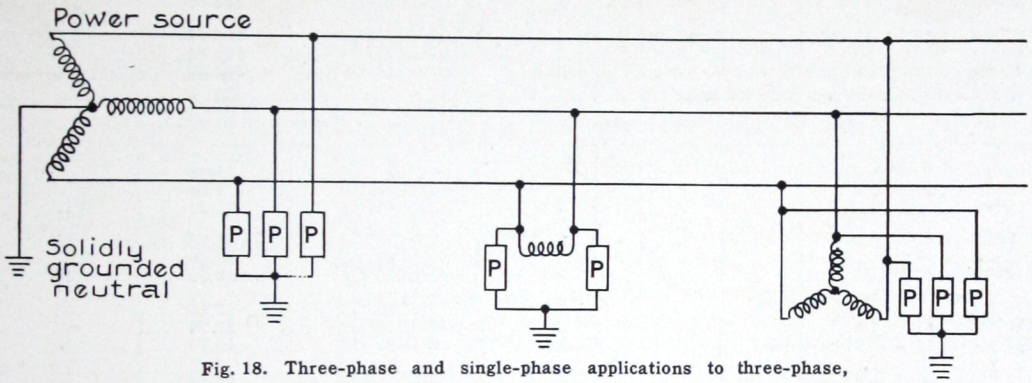


Fig. 18. Three-phase and single-phase applications to three-phase, three-wire, solidly grounded neutral systems.

"P" represents pellet arresters—rating can be less than line-to-line circuit voltage. Arrester is usually of next lower rating than used on delta or ungrounded neutral system. See Table 2, next page.

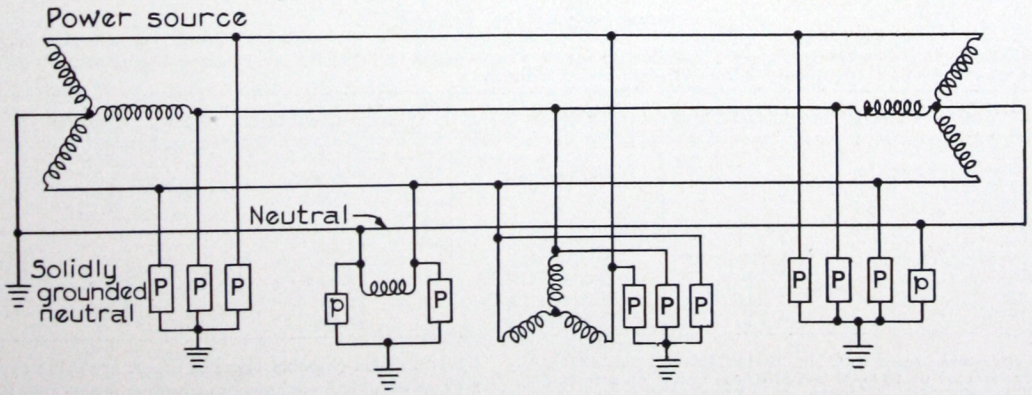


Fig. 19. Three-phase and single-phase applications to three-phase, four-wire, solidly grounded neutral system with neutral wire carried out.

"P" represents pellet arresters—rating can be less than line-to-line circuit voltage. Arrester is usually of next lower rating than used on delta or ungrounded neutral system.

"p" represents neutral arrester. Maximum rating equal to, or higher than, the potential from neutral wire to ground due to any phase unbalancing. The Cat. 146187 neutral arrester may be used when the potential of the neutral wire does not exceed 300 volts to ground. The Cat. 2906822G3 neutral arrester may be used when the potential of the neutral wire to ground is anywhere within the 0 to 750-volt rating.

The ground on the neutral wire at the power source does not in any way reduce the lightning potentials occurring on the neutral wire out on the circuit. It is therefore just as important to apply arresters to the neutral, as to the phase wires, where the neutral wire is connected to apparatus. See Table 2, next page.

Pellet and Compression-chamber Arresters

FOR OUTDOOR SERVICE ONLY

* CIRCUIT VOLTAGE CONSTANT POTENTIAL Min.	Max.	FIG. NO.	NO. OF ARRESTERS REQUIRED AT INSTALLATION Single-phase	Three-phase	CAT. NO.	LIST PRICE Each Class A	APPROX. SHIP. WT. in Lb. Each in Std. Pkg.	STANDARD PACKAGE
TABLE 1—FOR SYSTEMS WITH NONGROUNDED NEUTRAL								
0	750	14, 21	2	3	‡†2906822G1	**$4.35**	4	24
0	750	14, 22	1	...	‡†2906823G1	**7.00**	7	12
0	750	14, 21	2	3	‡†2906822G2	**4.20**	4	24
0	750	14, 22	1	...	‡†2906823G2	**6.70**	7	12
1000	3000	1, 23	2	3	2923407G1	**11.50**	12	12
3000	6000	2, 24	2	3	2596671G1	**21.30**	25	6
6000	9000	2, 24	2	3	2596671G2	**28.00**	37	6
6000	9000	26	2	3	**3929158G1	**28.00**	37	3
9000	12000	2, 24	2	3	2923487G2	**37.75**	42	3
9000	12000	26	2	3	**3929158G2	**37.75**	42	3
12000	15000	2, 24	2	3	2596671G3	**48.50**	47	3
12000	15000	3, 26	2	3	**3929158G3	**48.50**	45	3
15000	18000	2, 24	2	3	2923487G1	**65.00**	93	3
15000	18000	26	2	3	**3929158G4	**65.00**	55	3
18000	25000	13, 27	2	3	△3906318G1	**105.00**	280	1
25000	30000	12, 28	2	3	△3906318G2	**131.25**	355	1
30000	37000	10, 11, 29	2	3	△3906318G3	**169.25**	400	1
37000	50000	30	2	3	△2981437G4	**252.00**	510	1
50000	73000	31	2	3	△2981437G5	**382.00**	680	1
TABLE 2—FOR SYSTEMS WITH SOLIDLY GROUNDED NEUTRAL								
....	....	15, 20	§	...	† 146187	**$2.25**	1.3	24
....	....	14, 21	§	...	† 2906822G3	**4.20**	4	24
3000	5000	1, 23	§	3	2923407G1	**11.50**	12	12
5000	9000	2, 24	§	3	2596671G1	**21.30**	25	6
9000	12800	2, 24	§	3	2596671G2	**28.00**	37	6
9000	12800	26	§	3	**3929158G1	**28.00**	37	6
12800	15000	2, 24	§	3	2923487G2	**37.75**	42	3
12800	15000	26	§	3	**3929158G2	**37.75**	42	3
15000	18000	2, 24	§	3	2596671G3	**48.50**	47	3
15000	18000	3, 26	§	3	**3929158G3	**48.50**	45	3
18000	25000	2, 25	§	3	3929124G1	**65.00**	110	3
18000	25000	26	§	3	**3929158G5	**65.00**	60	3
25000	30000	13, 27	§	3	△3906318G1	**105.00**	280	1
30000	37000	12, 28	§	3	△3906318G2	**131.25**	355	1
37000	50000	10, 11, 29	§	3	△3906318G3	**169.25**	400	1
50000	73000	31	§	3	△2981437G7	**308.00**	600	1

FOR TWO-PHASE SYSTEMS

Treat installations on two-phase, four-wire systems like two single-phase installations on ungrounded-neutral three-phase systems. Recommendations on arresters for two-phase, three-wire systems on request.

TABLE 3—FOR PROTECTION OF LOAD SIDE OF A-C. SERIES LIGHTING TRANSFORMERS

KW. RATING OF TRANSFORMERS Secondary Amperes (6.6 and 7.5)	FIG. NO.	SINGLE-POLE CAT. NO.	LIST PRICE Class A	APPROX. SHIP. WT. in Lb. Each in Std. Pkg.	STANDARD PACKAGE
1, 2, 3	14, 21	†2906822G2	**$4.20**	4	24
5, 7.5, 10, 15	1, 23	2923407G1	**11.50**	12	12
20, 25, 30	2, 24	2596671G1	**21.30**	25	6
35, 40	2, 24	2596671G2	**28.00**	37	6
50, 60, 70	2, 24	2596671G3	**48.50**	47	3

*** ALTITUDE:** Arresters except Cat. No. 2981437G5 and 2981437G7 can be used at these ratings up to 6000 feet altitude, but when arresters Cat. No. 3906318G1, 3906318G2, 3906318G3, and 2981437G4 are to be used between 4000 and 6000 feet, the purchaser should state the approximate altitude at which they are to be installed so that they can be furnished with the correct gap setting. For altitudes above 6000 feet, the purchaser should obtain special recommendations for all arresters. Cat. No. 2981437G5 and 2981437G7 can be used only up to 4000 feet.

** These arresters are arranged for suspension mounting. Suspension clamp accommodates wire or cable .250—.625 inches diameter.

§ Use one arrester on outside wire at a single-phase installation made between an outside wire and neutral. Use also on neutral wire a Cat. No. 146187 or Cat. No. 2906822G3, if voltage to ground is not over 300 volts; if, on account of unbalancing, voltage is between 300 and 750 volts, use Cat. No. 2906822G3. Use two arresters at a single-phase installation between outside wires. A system is considered solidly grounded when no resistance or reactance is used in grounding the neutral.

△Cat. No. of arrester does not include any form of mounting. There may be included, at no increase in price, a mounting base or bracket. Refer to Table 4, next page.

† Compression-chamber type; all others are pellet type.

‡ These compression-chamber arresters are also suitable for grounded-neutral circuits of ratings up to 750 volts. The following table shows how they differ.

CAT. NO.	POLES	LENGTH LEAD IN INCHES Line	Ground
2906822G1	Single	36	18
2906822G2	Single	18	18
2906823G1	Double	36	18
2906823G2	Double	18	18

TABLE 4—MOUNTINGS FOR PELLET ARRESTERS

Arresters of the following Cat. Numbers do not include mounting supports. There may be included, at no increase in price, a mounting base or bracket, which must be ordered by Cat. No. as follows:

CAT. NO. OF ARRESTER	CHANNEL-IRON BASE			CAST-IRON BASE			BRACKET		
	Cat. No.	Ship. Wt. in Lb.	Fig. No.	Cat. No.	Ship. Wt. in Lb.	Fig. No.	Cat. No.	Ship. Wt. in Lb.	Fig. No.
3906318G1	2981434G2	14	33	.....	..	..	2981434G1	80	35
3906318G2	2981434G2	14	33	.....	..	..	2981434G1	80	35
3906318G3	2981434G2	14	33	.....	..	..	2981434G1	80	35
2981437G4	2981434G2	14	33	1523295G2	12	34	2981429G1	145	36
2981437G5	2981434G2	14	33	1523295G2	12	34	2981429G1	145	36
2981437G7	2981434G2	14	33	1523295G2	12	34	2981429G1	145	36

When ordering arresters, specify the Cat. No. of the arrester desired and also the Cat. No. of the bracket or base.
The arresters are packed in lots of three, bases or brackets separately. If the arresters should be packed individually, the order should so state.

DIMENSIONS OF COMPRESSION-CHAMBER ARRESTERS

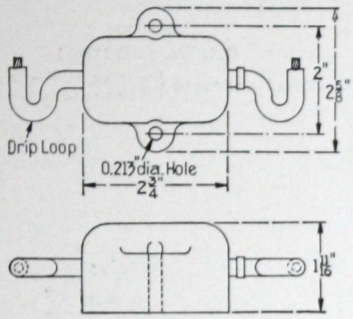


Fig. 20
Cat. No. 146187
Line lead, 18 in.—Ground lead, 18 in.

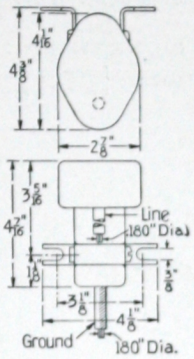


Fig. 21
Cat. No. 2906822G1, Single-pole
Line lead, 36 in.—Ground lead, 18 in.
Cat. No. 2906822G2, Single-pole
Line lead, 18 in.—Ground lead, 18 in.
Cat. No. 2906822G3, Single-pole
Line lead, 18 in.—Ground lead, 18 in.

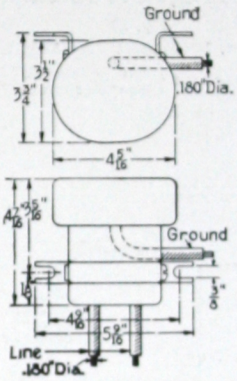


Fig. 22
Cat. No. 2906823G1, Double-pole
Line lead, 36 in.—Ground lead, 18 in.
Cat. No. 2906823G2, Double-pole
Line lead, 18 in.—Ground lead, 18 in.

DIMENSIONS OF PELLET ARRESTERS

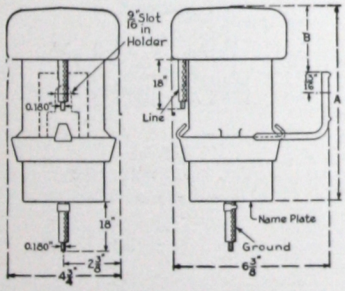


Fig. 23

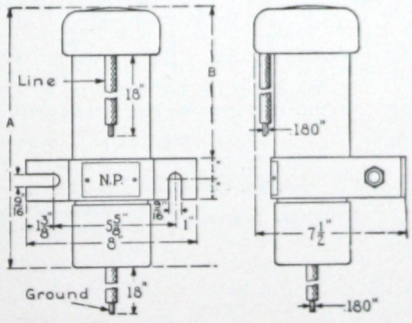


Fig. 24

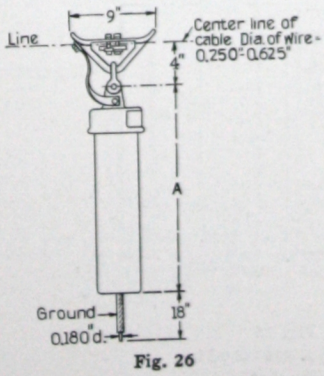


Fig. 26

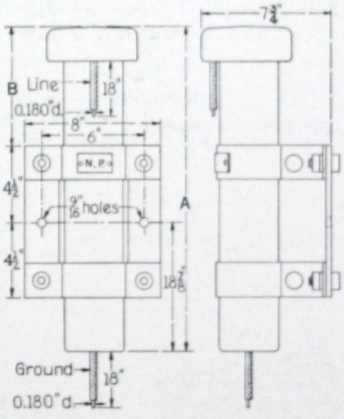


Fig. 25

CAT. NO.	FIG. NO.	DIMENSIONS IN INCHES	
		A	B
2923407G1	23	8 1/4	2 1/2
2596671G1	24	15 9/16	8 3/16
2596671G2	24	22 5/16	11 13/16
2923487G2	24	27	15
2596671G3	24	31 3/16	17 1/16
2923487G1	24	42 7/16	24 7/16
3929124G1	25	47 13/16	24 7/16

CAT. NO.	FIG. NO.	DIMENSIONS IN INCHES
		A
3929158G1	26	25
3929158G2	26	29
3929158G3	3, 26	33 1/4
3929158G4	26	44 7/8
3929158G5	26	50 1/4

DIMENSIONS OF PELLET ARRESTERS (Cont.)

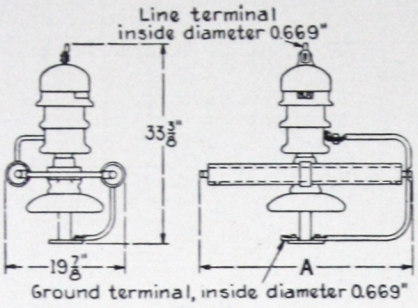


Fig. 27
Cat. No. 3906318G1 A = 34¾ In.
Electrical clearance { line to line—13 In. / line to ground—7½ In.

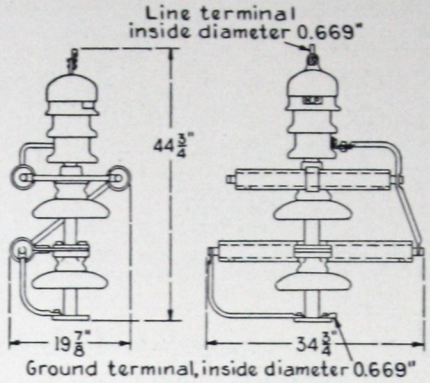


Fig. 28
Cat. No. 3906318G2
Electrical clearance { line to line—15½ In. / line to ground—9 In.

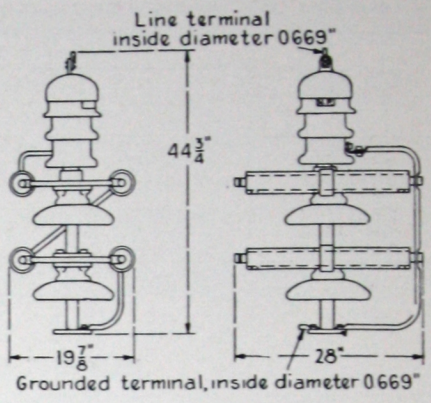


Fig. 29
Cat. No. 3906318G3
Electrical clearance { line to line—19 In. / line to ground—11 In.

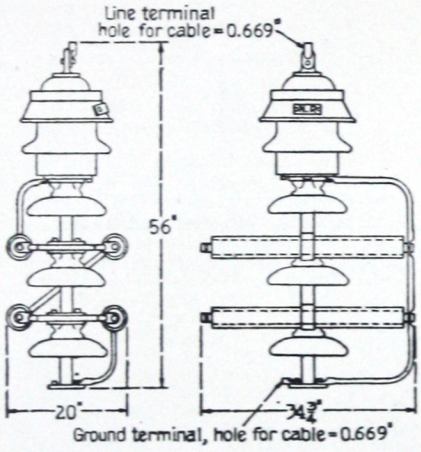


Fig. 30
Cat. No. 2981437G4
Electrical clearance { line to line—26 In. / line to ground—15 In.

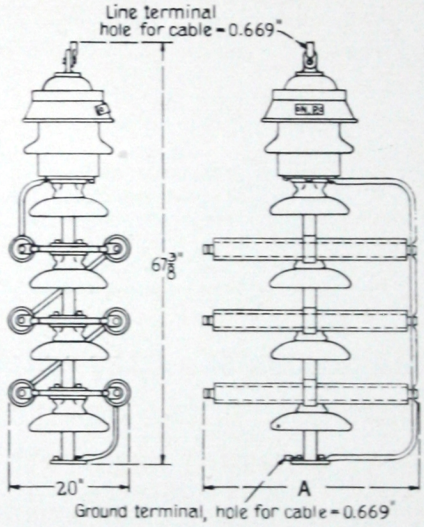


Fig. 31
Cat. No. 2981437G5 A = 34¾ In.
Cat. No. 2981437G7 A = 28 In.
Electrical clearance { line to line—38 In. / line to ground—22 In.

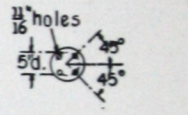


Fig. 32
Plan of insulator base drilling for all arresters on this page

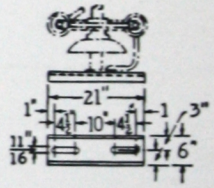


Fig. 33
Cat. No. 2981434G2
Channel-iron base

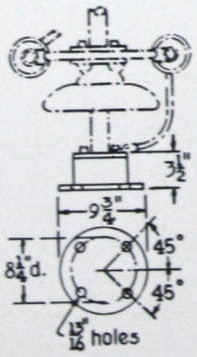


Fig. 34
Cat. No. 1523295G2
Cast-iron base

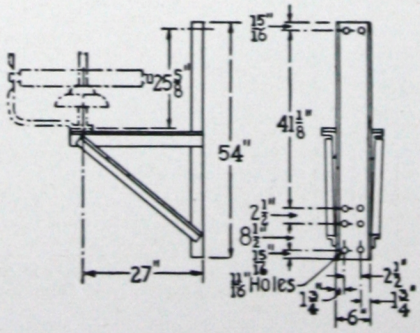


Fig. 35
Cat. No. 2981434G1
Bracket

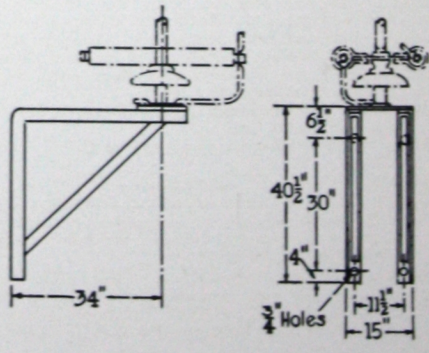


Fig. 36
Cat. No. 2981429G1
Bracket

GENERAL ELECTRIC COMPANY

GENERAL OFFICE SCHENECTADY, N. Y.

Sales Offices—Address Nearest Office

Akron, Ohio ..... 106 South Main Street
Atlanta, Ga. ..... 187 Spring Street, Northwest
Baltimore, Md. ..... 39 West Lexington Street
Beaumont, Tex. ..... 398 Pearl Street
Binghamton, N. Y. ..... 19 Chenango Street
Birmingham, Ala. ..... 2031 First Avenue, North
Bluefield, W. Va. ..... 307 Federal Street
Boston, Mass. ..... 140 Federal Street
Buffalo, N. Y. ..... 1 West Genesee Street
Butte, Mont. ..... 20 West Granite Street
Canton, Ohio ..... 700 Tuscarawas Street, West
Charleston, W. Va. ..... 304 Capitol Street
Charlotte, N. C. ..... 200 South Tryon Street
Chattanooga, Tenn. ..... 536 Market Street
Chicago, Ill. ..... 230 South Clark Street
Cincinnati, Ohio ..... 215 West Third Street
Cleveland, Ohio ..... 925 Euclid Avenue
Columbus, Ohio ..... 17 South High Street
Dallas, Tex. ..... 1801 North Lamar Street
Davenport, Iowa ..... 511 Pershing Avenue
Dayton, Ohio ..... 25 North Main Street
Denver, Colo. ..... 650 Seventeenth Street
Des Moines, Iowa ..... 418 West Sixth Avenue
Detroit, Mich. ..... 700 Antoinette Street
Duluth, Minn. ..... 14 West Superior Street
El Paso, Tex. ..... 109 North Oregon Street
Erie, Pa. ..... 10 East Twelfth Street
Fort Wayne, Ind. ..... 1635 Broadway
Fort Worth, Tex. ..... 408 West Seventh Street
Grand Rapids, Mich. ..... 148 Monroe Avenue, Northwest
Hartford, Conn. ..... 18 Asylum Street
Houston, Tex. ..... 1016 Walker Avenue
Indianapolis, Ind. ..... 110 North Illinois Street
Jackson, Mich. ..... 212 Michigan Avenue, West
Jacksonville, Fla. ..... 700 East Union Street
Kansas City, Mo. ..... 106 West Fourteenth Street
Knoxville, Tenn. ..... 602 South Gay Street
Los Angeles, Calif. ..... 5201 Santa Fe Avenue
Louisville, Ky. ..... 455 South Fourth Street
Memphis, Tenn. ..... 8 North Third Street
Miami, Fla. ..... 120 Northeast Twentieth Street
Milwaukee, Wis. ..... 940 West St. Paul Avenue
Minneapolis, Minn. ..... 107 South Fifth Street
Nashville, Tenn. ..... 234 Third Avenue, North
Newark, N. J. ..... 744 Broad Street
New Haven, Conn. ..... 129 Church Street
New Orleans, La. ..... 837 Gravier Street
New York, N. Y. ..... 120 Broadway
Niagara Falls, N. Y. ..... 201 Falls Street
Oklahoma City, Okla. ..... 119 North Robinson Street
Omaha, Nebr. ..... 409 South Seventeenth Street
Philadelphia, Pa. ..... 1405 Locust Street
Phoenix, Ariz. ..... 11 West Jefferson Street
Pine Bluff, Ark. ..... 501 Main Street
Pittsburgh, Pa. ..... 535 Smithfield Street
Portland, Ore. ..... 329 Alder Street
Providence, R. I. ..... 76 Westminster Street
Richmond, Va. ..... 700 East Franklin Street
Roanoke, Va. ..... 202 South Jefferson Street
Rochester, N. Y. ..... 89 East Avenue
St. Louis, Mo. ..... 112 North Fourth Street
Salt Lake City, Utah ..... 200 South Main Street
San Antonio, Tex. ..... 201 Villita Street
San Francisco, Calif. ..... 235 Montgomery Street
Schenectady, N. Y. ..... 1 River Road
Seattle, Wash. ..... 821 Second Avenue
Shreveport, La. ..... 759 Ratcliff Street
Spokane, Wash. ..... 421 Riverside Avenue
Springfield, Ill. ..... 607 East Adams Street
Springfield, Mass. ..... 1387 Main Street
Syracuse, N. Y. ..... 113 South Salina Street
Tacoma, Wash. ..... 1019 Pacific Avenue
Tampa, Fla. ..... 604 Ella Mae Street
Toledo, Ohio ..... 405 Madison Avenue
Trenton, N. J. ..... 143 East State Street
Tulsa, Okla. ..... 409 South Boston Street
Utica, N. Y. ..... 258 Genesee Street
Washington, D. C. ..... 800 Fifteenth Street, Northwest
Waterbury, Conn. ..... 195 Grand Street
Wheeling, W. Va. ..... 1717 Eoff Street
Worcester, Mass. ..... 340 Main Street
Youngstown, Ohio ..... 25 East Boardman Street

Canada: Canadian General Electric Company, Ltd., Toronto

Hawaii: W. A. Ramsay, Ltd., Honolulu

Motor Dealers and Lamp Agencies in all large cities and towns

SERVICE SHOPS

Atlanta, Ga. ..... 496 Glenn Street, Southwest
Buffalo, N. Y. ..... 318 Urban Street
Chicago, Ill. ..... 509 East Illinois Street
Cincinnati, Ohio ..... 215 West Third Street
Cleveland, Ohio ..... 4966 Woodland Avenue
Dallas, Tex. ..... 1801 North Lamar Street
Detroit, Mich. ..... 5950 Third Avenue
Houston, Tex. ..... 5 North Milam Street
Kansas City, Mo. ..... 819 East Nineteenth Street
Los Angeles, Calif. ..... 5203 Santa Fe Avenue
Milwaukee, Wis. ..... 940 West St. Paul Avenue
Minneapolis, Minn. ..... 410 Third Avenue, North
New York, N. Y. ..... 416 West Thirteenth Street
Philadelphia, Pa. ..... 429 North Seventh Street
Pittsburgh, Pa. ..... 16 Terminal Way
St. Louis, Mo. ..... 1009 Spruce Street
Salt Lake City, Utah ..... 360 West Second South Street
San Francisco, Calif. ..... 340 First Street
Seattle, Wash. ..... 1508 Fourth Avenue, South

Special service divisions are also maintained at the following works of the Company: Erie, Pa.; Ft. Wayne, Ind.; Pittsfield, Mass.; Schenectady, N. Y.; and West Lynn, Mass.—River Works and West Lynn Works.

INTERNATIONAL GENERAL ELECTRIC COMPANY, INC.

Executive Offices: 120 Broadway, New York City SCHENECTADY, N. Y. Cable Address: "Ingenetric New York"

FOREIGN OFFICES, ASSOCIATED COMPANIES, AND AGENTS

ARGENTINA: General Electric, S. A., Buenos Aires, Cordoba, Rosario de Santa Fe, Tucuman, and Mendoza

AUSTRALIA: Associated General Electric Industries, Ltd., Sydney; Associated General Electric Apparatus Co., Ltd., Sydney and Melbourne; Associated General Electric Specialties Co., Ltd., Sydney and Melbourne; Associated General Electric Supplies Co., Ltd., Sydney, Melbourne, Lismore, Newcastle, Adelaide, Albury, Box Hill, Brisbane, Colac, Rockhampton, and Townsville

BELGIUM AND COLONIES: Societe d'Electricite et de Mecanique (Procedes Thomson-Houston & Carels), Brussels, Belgium

BRAZIL: General Electric, S.A., Rio de Janeiro, Sao Paulo, Bahia, Porto Alegre, Bello Horizonte, Belem, Curityba, Santos, and Recife

CHILE: International Machinery Company, Santiago, Antofagasta, and Valparaiso; Nitrate Agencies, Ltd., Iquique

CHINA: Andersen, Meyer & Company, Ltd., Shanghai; China General Edison Company, Shanghai

COLOMBIA: International General Electric, S.A., Barranquilla, Bogota, Medellin, and Cali

CUBA: General Electric Company of Cuba, Havana, and Santiago de Cuba

ECUADOR: Guayaquil Agencies Co., Guayaquil

EGYPT: British Thomson-Houston Company, Ltd., Cairo

FRANCE AND COLONIES: Compagnie Francaise Thomson-Houston, Paris; International General Electric Co., Inc., Paris; Compagnie Des Lampes, Paris

GERMANY: H. B. Peirce, Representative, General Electric Co., Berlin

GREAT BRITAIN AND IRELAND: International General Electric Co. of New York, Ltd.; British Thomson-Houston Co., Ltd., London, W.C.2; British Thomson-Houston Co., Ltd., Rugby

GREECE AND COLONIES: Compagnie Francaise Thomson-Houston, Paris, France

HOLLAND: Mijnssen & Co., Amsterdam

INDIA: International General Electric Company, (India), Ltd., Calcutta, Bombay, Bangalore, and Lahore

ITALY AND COLONIES: Compagnia Generale Di Elettricita, Milan

JAPAN: Shibaura Engineering Works, Tokyo; Tokyo Electric Company, Ltd., Kawasaki, Kanagawa-Ken; International General Electric Co., Inc., Tokyo

JAVA: International General Electric Co., Inc., Soerabaia

MEXICO: General Electric, S.A., City of Mexico, Monterrey, Vera Cruz, and El Paso, Texas

NEWFOUNDLAND: International General Electric Co., Inc., St. Johns

NEW ZEALAND: National Electrical and Engineering Company, Ltd., Auckland, Dunedin, Christchurch, and Wellington

PARAGUAY: General Electric, S. A., Buenos Aires, Argentina

PERU: International Machinery Co., Lima

PHILIPPINE ISLANDS: Pacific Commercial Company, Manila; General Electric Appliance Corp. of the Philippines, Manila

PORTO RICO: International General Electric Company of Porto Rico, San Juan

PORTUGAL AND COLONIES: Sociedade Iberica de Construções Electricas Lda., Lisbon

SOUTH AFRICA: South African General Electric Company, Ltd., Johannesburg, Capetown, Durban, and Port Elizabeth

SPAIN AND COLONIES: Sociedad Iberica de Construcciones Electricas, Madrid, Barcelona, Bilbao, Valladolid, and Sevilla

SWITZERLAND: Trolliet Freres, Geneva

URUGUAY: International General Electric, S.A., Montevideo

VENEZUELA: International General Electric, S.A., Caracas and Maracaibo